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Transportation Research Procedia 14 (2016) 2785 – 2794

Transportation Research Procedia

www.elsevier.com/locate/procedia

6th Transport Research Arena April 18-21, 2016

Eco-optimisation of goods supply by road transport: from logistic requirements via freight transport cycles to efficiency-maximised vehicle powertrains

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Abstract

Currently, only a small minority of commercial vehicles on the market are fitted with alternative powertrain systems, and they are mostly of the heavy-duty type. The “alternative” components required (in particular batteries) make these utility vehicles rather expensive for fleet operators. The return on investment seems to be still out of reach. Hence, it is necessary to cut down on operational costs. Given these facts, the starting point was to clarify the criteria of logistic services as needed by the customers. First and foremost this concerns the type of vehicle chosen for a given logistic task. Secondly, concern needs to be given to the factors which influence the dynamics of vehicle movements, such as the load factor in terms of the geographical sequence of the points of deliveries. Thirdly, the time windows available for delivery affect variations in the velocity dependent on the respective level of service of the traffic flow. This opens up some additional potential for optimisation aside from vehicle technology. Road network planning and traffic management can boost low-emission freight services by taking into consideration the performance of different powertrain systems.

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Peer-review under responsibility of Road and Bridge Research Institute (IBDiM)
doi:10.1016/j.trpro.2016.05.475

The object was to quantify effects of innovative powertrain technologies on freight transport fleets with respect to reducing energy consumption and CO_2 equivalent emissions. We identified representative logistic services as framework conditions of their operations in correlation with vehicle classes (light, medium and heavy). The vehicles use routes from the outskirts to the core of a conurbation and vice versa. The roads used are defined in categories which allow estimates of their capacity to handle variable traffic flows depending on the time of the day. These boundary conditions were used for a comprehensive comparison (based on numerical simulations) of advanced powertrain systems for such commercial vehicles. Particularly, fuel types as well as electricity were taken into account along with some variation in gross vehicle weights and hybrid configurations.
The investigations were carried out for 32 different powertrain architectures such as advanced diesel and CNG engines, also as baselines for different hybrid variants and even pure battery-powered commercial vehicles. The results should be of interest for fleet operators, and our interpretations regarding further energy and emission reductions in goods supply processes challenges the entire future system of logistics, traffic management, infrastructure planning and powertrain technologies.

Peer-review under responsibility of Road and Bridge Research Institute (IBDiM)

Keywords: Commercial vehicles; power train systems; freight transport cycles; traffic flow; table of indicators

1. Data input modelling of freight transport runs onto the road network

1.1. Methodical approach

Great expectations accompany the marketable development and spread of utility vehicles that handle freight transports at ever lower or even zero emission rates. To this end, several powertrain concepts have already been developed to a high degree of technological maturity, which are currently offered or soon to be available to fleet operators in a wide range of vehicles. Which of these variants will in the short run prevail in the utility vehicle market will depend on the economics of their purchase (total cost of ownership) and their competitiveness in the transport logistics market, considering that freight transport is ruled by fierce competition so that established technology (such as diesel drives) and predictable vehicle costs are indispensable considerations for the providers of transport services.

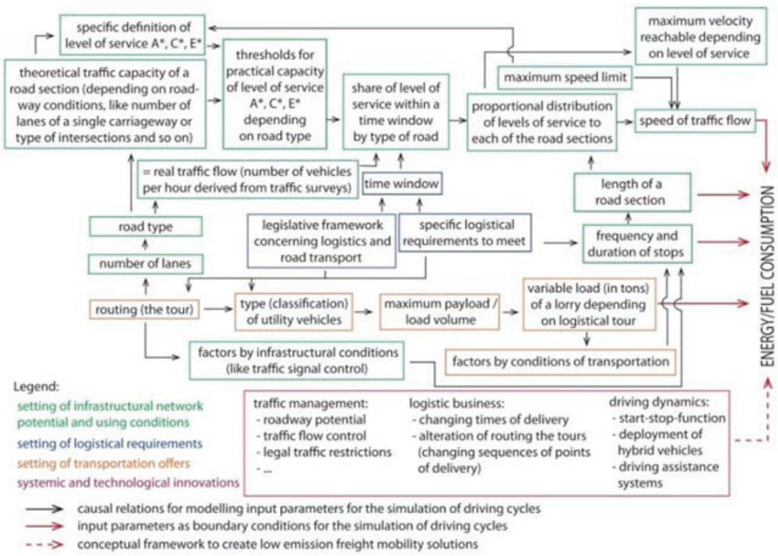

Fig. 1. External influence factors on driving dynamics determining energy/fuel consumption and emissions of a logistic run.

It is thus time to look into how freight transport vehicles are used in order to investigate the economic suitability of alternative models under everyday conditions. As there are currently few such models to be found in the stock of vehicles and on the road, we need simulations based on regular transports for the supply of goods to the population and the regional economy. For this purpose, we use so-called driving cycles, routes of logistic runs where the powertrain is exposed to different usages depending on road and driving conditions and on the (varying, load-dependent) weight of the utility vehicle. The EFLOG project (BMVIT 2014) accordingly developed a model (see Fig. 1) to produce input data which are used to simulate driving cycles performed with the simulation tool AVL CRUISE.

In this model, the route of a transport run acts as an interface between the driving dynamics resulting from the powertrain technology chosen and the factors influencing the defined logistic tasks and the external road conditions encountered by the vehicle on its run (Dörr et al. 2015).

1.2. Logistical requirements

The transport chain is determined by the tour schedule planned and carried out upon the instructions issued by the shipper or recipient of the goods. It comprises the density, number of delivery points (such as points of sale, points of delivery, etc.) to be approached and the scope of unloading. Such logistic requirements determine the choice of the transport regime (make or buy) and the type of vehicle used, the parameters of which, such as the total vehicle weight changing in the course of the run, are varied across the sections of the overall route.

The structure of this model enables us to consider various ways of logistically handling goods drops in agglomerations and rural regions or transport lanes in point-to-point traffic to simulate cruise cycles. To start with, three model transport runs were assumed within the Vienna metropolis, consisting of the following components:

They involve two distribution runs from logistics warehouses situated in the vicinity of the core town to an urban destination district. The first run consists of a CEP (courier, express and parcel) service, handled by an N1 utility vehicle in 34 stops at a starting payload of 0.9 tons. The second run delivers food in an N2 utility vehicle to nine stops at a starting payload of 4.5 tons. Both runs extend for some 40 km from start to end. In addition, an industrial delivery run was assumed from an urban manufacturing location (such as a brewery) to a major customer outside the city, handled by an N3 utility vehicle (such as an articulated lorry). The lorry carries a load of 20 tons (e.g. on pallets) for a total mileage of 36 km, running empty for half the distance.

Such runs are made with typical utility vehicles of European categories N1 (up to 3.5 tons in gross vehicle weight), N2 (12 tons) and N3 (up to 40 tons, although in our case the assumption was limited to 35 tons). For each run, customary time windows from the warehouse were defined for the simulation: 8 a.m. to 5 p.m. for the CEP services using the N1 vehicle; 6 a.m. to 8 p.m. for the food run using the N2 vehicle, and 5 p.m. to 10 p.m. for the industrial delivery using the N3 vehicle. This means that several similar runs can be arranged within the given time windows which add up in the result. The time windows are decisive for the marginal conditions of the traffic quality encountered during the run.

1.3. Infrastructural frame

After screening 22 routes which link the vicinity to the metropolis and carry a high ratio of delivery lorries, the route from the Industriezentrum Niederösterreich Süd business park located at the Southern Motorway A2 to Ottakring, a district of Vienna with tenement-housing mostly dating back to the Gründerzeit, was chosen (Fig. 2). The business park features numerous central logistic warehouses to supply the agglomeration with goods, as well as haulers settled next to freight forwarders and wholesalers. The Ottakring district is densely populated and has a grid layout which facilitates handling the high frequency of goods delivery. The delivery vehicles use this route which consists of three characteristic types of road: motorway, arterial road and local road network.

The model required defining the specifics of each type of road: roadway conditions such as the number of lanes, distances between intersections, gradients, traffic signal-controlled intersections and specific restrictions that shape the capacity of a road. In this manner, the route used can be broken down by means of road network graphs into sections and by categories (BMVIT 2011).

A section is marked by changes in lane conditions, e.g. from a two-lanes two-carriageways to a two-lanes single-carriageway road, or by stops during the run. The latter may be traffic-caused stops such as red lights or logistically caused stops when goods are shifted at a point of delivery.

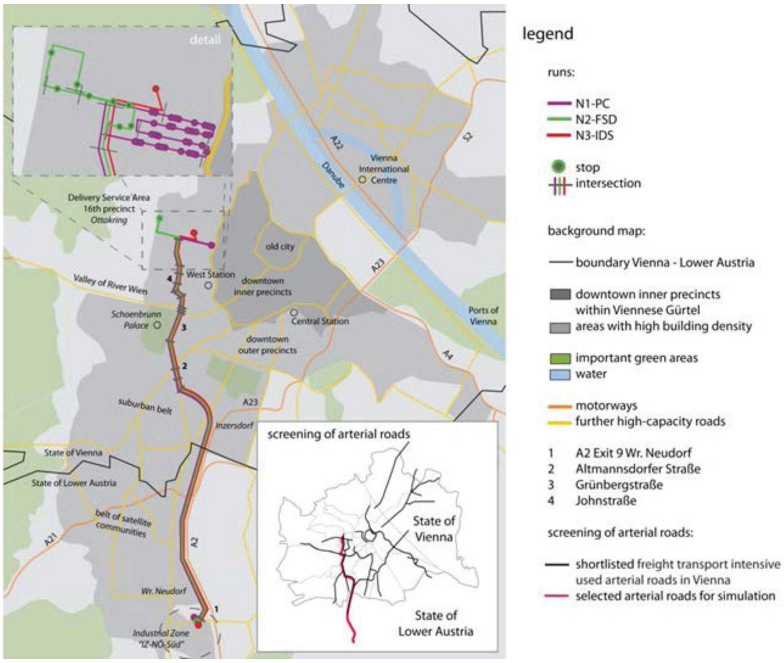

Fig. 2. Reference route for freight transport cycle simulations.

1.4. Daily traffic flow characteristics

Added to these static factors are dynamic factors that affect driving dynamics of the freight vehicle on the overall traffic flow. This includes an interpretation of the day-to-day traffic situation, obtained from observational traffic surveys by automated detection. The model used the results of the UNECE survey of 2010 for the state of Vienna, which involved 96 time cuts in 24 hours pursuant to Käfer Verkehrsplanung (2011).

This supplied changes in traffic flow in 15-minute steps for about 100 counting points across Vienna. These in turn provided traffic maps showing the daily variation of traffic flows in order to obtain a characteristic proportional distribution of the quality of the traffic flow for the three road categories. The quality was categorised by comparing the theoretical capacity with the observed traffic flow across the day (FGSV 2001).

The traffic quality is defined as Level of Service (LoS) analogously to the approach used in the Highway Capacity Manual (2010). Starting out from the classical six-stage approach from A (free flow) to F (stop and go), stages A and B were combined into A*; C and D became C*; and E and F reverted to E* (O'Flaherty 1997). This was done mainly because utility vehicles of a gross vehicle weight in excess of 3.5 tons are subject to a speed limit and thus unable to use LoS A in the same way that passenger cars do. This three-stage LoS concept is certainly adequate for the road dynamics of heavy utility vehicles.

Based on the traffic flows across the day as they are typical for the three road categories (at least in terms of the Vienna network of roads), the shares of LoS stages A*, C* and E* for the specific time windows of the three logistic runs were allocated pro rata to the section lengths. This impacts on the velocity achievable by the utility vehicles by categories (N1, N2, N3) in terms of the road conditions prevailing in the various sections, which is then used as an input parameter for the driving cycle simulation. Using a base diagram (INRETS 2004) of the dynamics of driving (comprising phases of acceleration, sailing and deceleration respectively) between two stops, we get the velocity to be achieved for each section depending on the length of the run (Fig. 3).

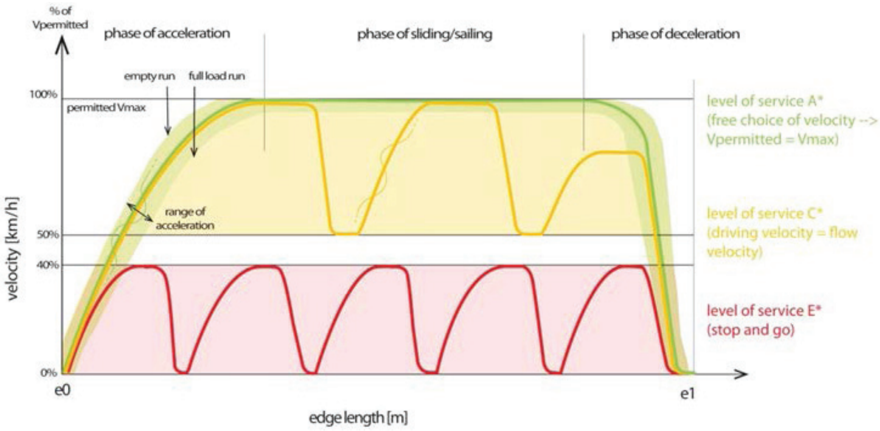

Fig. 3. Base diagram: variation of velocity depending on road capacity utilisation (level of service).

Based on these marginal conditions for the dynamics of driving a simulation of the required torque was carried out, which then yields the performance of the powertrain in operation in terms of energy (fuel) consumption and exhaust gas emission. An example for the different traffic flow conditions within the time window for the food supply service is given in Fig. 4 that depicts a logistic run of the N2 vehicle touring from the fringes of the city into its urban core.

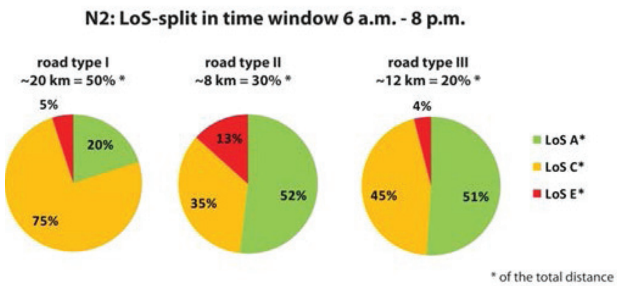

Fig. 4. Traffic situations in time window of a food supply logistic run depending on road types.

2. Freight transport cycle simulations

2.1. General boundary conditions for freight transport cycle simulations

The simulations were performed for the three European utility vehicle categories N1, N2 and N3. As a basis from each category a vehicle was chosen which constitutes the current state of the art and is widely used by commercial fleets. Vehicles of these categories carry out typical logistic runs on a day-to-day basis and thus represent actual driving cycles. The target velocity curves do not give specifications for the acceleration phases but abruptly set the final velocity so that the simulation's "controller" (i.e. the fictitious driver) attempts to reach the target velocity (e.g. 50 kilometres per hour in the town or up to 130 kilometres per hour on a motorway) at full torque operation. This closely approximates the typical operation of such utility vehicles. The timeline of the vehicle's loading state and thus the weight variations across the run were accounted for in each vehicle/cycle combination as a key marginal factor impacting on energy consumption.

Moreover, a shift strategy optimised for lowest fuel consumption was assumed throughout. Vehicles that have no stop-start feature were simulated as having its combustion engine running throughout, including the loading and delivery procedures. In order to obtain realistic consumption values, add-on users such as air conditioning, electric servo steering and electric generators were accounted for in each of the simulated vehicle models.

The simulation mathematically maps selected vehicle models in terms of their longitudinal dynamic properties and runs them along the driving and load cycles as designed for the logistic runs. This includes velocity and altitude profiles for the run, which are incorporated as marginal conditions. Accounting for the vehicle and power train specification (mass, driving resistance, engine characteristics, powertrain architecture, subsystem parameters such as transmission ratios of a gearbox, etc.) and strategy (gear chosen, etc.), this yields the engine speed and engine load as parameters of relevance for fuel consumption. Using these two parameters the model automatically produces the actual specific fuel consumption which is integrated to obtain total consumption per cycle and CO_2 equivalent emissions.

2.2. System architecture and hybrid components for selected utility vehicles N1, N2 and N3

As regards the choice of specifications for the powertrains of the utility vehicle categories it should be noted that the simulation initially used base variants of traditional combustion engines, powered either by diesel or Compressed Natural Gas (CNG). The latter has a lower energy density than diesel which has to be taken into account (Fig. 5). This produced values suitable to compare different powertrain systems (two conventional drives, several hybrid drives and electric motors). All systems of a given vehicle category were considered as having the same performance (N1 at 120 kW, N2 at 155 kW and N3 at 330 kW) sufficient for the three logistic runs in the traffic environment of an agglomeration. A distinction is made between parallel hybrids (parallel hybrids, parallel connection), where the torque of both, the internal combustion engine and the e-motor, can be used to propel the vehicle, and serial hybrid (serial hybrid, serial connection) where the combustion engine drives a generator which provides the electricity for the propulsion e-motor(s).

- *Micro Hybrid Electric Vehicle (HEV) – P1 (based on diesel or CNG combustion engine)*: the smaller electric motor is chiefly used for the start/stop function, i.e. the engine shuts down automatically when the vehicle stops. Energy recuperation is very low, so that small battery dimensions suffice (parallel hybrid concept).
- *Mild Hybrid Electric Vehicle – P1 (diesel or CNG)*: A light type of hybrid with a power of the e-motor of 10–15 kW, the electric motor recuperates part of the energy and acts as a starter booster (parallel hybrid concept).
- *Full Hybrid P2 (diesel or CNG)*: This two-engine concept (a full scale combustion engine and e-motor(s)) permits operating the vehicle solely by electric power for a short distance (parallel hybrid concept).
- *Plug-In Hybrid P2 / dual energy concept (diesel)*: Approximately, the same powertrain architecture as the Full Hybrid P2. Purely electric operation is possible but requires a larger battery than that fitted in a Full Hybrid. The battery must be externally recharged via a power cable.
- *Power Split Hybrid / PS (diesel)*: This variant with an epicyclic gear to distribute power to the drive and for generation is a complex system, used e.g. in the passenger car Toyota Prius. It is less efficient in utility vehicles as considered by us and is not expected to prevail.
- *Serial Hybrid (diesel)*: A combustion engine generates energy for the electric motor which powers the vehicle. The system is comparable to a diesel-electric train engine. We distinguish two types of Serial Hybrid vehicles. In the best-point mode (S HEV 1) the combustion engine serves as a generator, operated for a constant power at a working point with optimum consumption. To this end it requires a large battery for buffering. As a line-mode engine (S HEV 2), its power is continuously adjusted to the required output of the electric motor so that it can be operated at others than the optimum consumption working point. The Serial Hybrid was simulated by two differently sized (40 kW and 120 kW) combustion engines.
- *Battery Electric Vehicle BEV*: Supplied by a high-performance battery and fitted with a Plug-In charger, the vehicle has no combustion engine and was simulated for N1 and N2. With respect to emission reduction the electricity production mix has to be taken into account, therefore a non-exhausted rest remains (Fig. 5).

No fuel cell vehicle needs to be included because this is a zero-emission electric vehicle and, moreover, utility vehicles of this type suitable for goods transport do not yet exist. Moreover, such vehicles need first to overcome the market entry barrier of a hydrogen supply chain which requires a – not yet existent – expensive infrastructure at the refuelling station. In contrast to BEVs they easily enable a reach of 600 km on a single filling, and filling itself will require typically only 5-10 minutes if a minimum coverage of tanking points over the country were available.

Table 1. System architecture and Hybrid Components as selected for Utility Vehicles N1, N2 and N3.

	fuel	system power			range		battery system		weight*	
		total	com-bustion engine	e-motor nominal power	total	emission-free	techno-logy	capa-city	net weight	max. pay-load
		kW	kW	kW	km	km	–	kWh	kg	kg
vehicle variations and components N1										
conventional	diesel	120	120	–	500	–	–	–	2.100	1.400
	CNG				400	–			2.150	1.350
Micro Hybrid P1 (BSG)	diesel	120	120	10	500	–	–	–	2.120	1.380
	CNG	120	120		400	–			2.170	1.330
Mild Hybrid (CSG I)	diesel	120	120	20	500	–	Li-Ion	1	2.140	1.360
	CNG	120	120		400	–			2.190	1.310
Full Hybrid P2 (CSG II / TISG)	diesel	120	120	40	500	–	Li-Ion	2	2.180	1.320
	CNG	120	120		400	–			2.230	1.270
Plug-In Hybrid P2 / Dual Energy concept	diesel	120	120	60	500	200	Li-Ion	10	2.270	1.230
PowerSplit Hybrid (PS)	diesel	120	120	EP: 80 GEN: 60	500	60	Li-Ion	5	2.320	1.180
Serial Hybrid (best point-mode) (SH)	diesel	120	40	EP: 120 GEN: 40	500	60	Li-Ion	10	2.350	1.150
Serial Hybrid (line-mode) (SH)	diesel	120	120	EP: 120 GEN: 120	500	60	Li-Ion	5	2.360	1.140
Battery Electric Vehicle	electricity	120	–	120	100	100	Li-Ion	50	2.500	1.000
vehicle variations and components N2										
conventional	diesel	155	155	–	650	–	–	–	4.500	7.500
	CNG				550	–			4.700	7.300
start stop	diesel	155	155	–	650	–	–	–	4.500	7.500
	CNG				550	–			4.500	7.500
P2 (CSG I)	diesel	155	155	40	650	–	Li-Ion	3	4.600	7.400
	CNG				550	–			4.800	7.200
P2 (TISG)	diesel	155	155	80	650	–	Li-Ion	5	4.660	7.340
	CNG				550	–			4.860	7.140
Plug-In Hybrid	diesel	155	155	155	650	220	Li-Ion	20	4.850	7.150
Serial Hybrid (best point-mode) (SH)	diesel	155	50	EP: 155 GEN: 50	650	80	Li-Ion	15	4.820	7.180
Serial Hybrid (line-mode) (SH)	diesel	155	155	EP: 155 GEN: 155	650	80	Li-Ion	8	4.850	7.150
Battery Electric Vehicle	electricity	155	–	155	100	100	Li-Ion	80	5.050	6.950
vehicle variations and components N3										
conventional	diesel	330	330	–	2.000	–	–	–	15.000	25.000
	CNG				1.500	–			15.000	25.000
start stop	diesel	330	330	–	2.000	–	–	–	15.000	25.000
	CNG				1.500	–			15.000	25.000
P2 HEV (CSG I)	diesel	330	330	60	2.000	–	Li-Ion	5	15.140	24.860
	CNG				1.500	–			15.140	24.860
P2 HEV (TISG)	diesel	330	330	120	2.000	–	Li-Ion	10	15.240	24.760
	CNG				1.500	–			15.240	24.760

EP = available e-motor power for driving, GEN = maximum recuperation power of electric machine as generator

* reference load:

N1: net weight + variable loading condition: starting load 500 kg, 34 unloadings, end 180 kg, because of undeliverable returns

N2: net weight + variable loading condition: starting load 4.500 kg, 9 unloads, end 0 kg

N3: net weight + variable loading condition: outward journey = empty run, return journey = full load run (20 t)

2.3. Vehicle-specific data input for simulations of freight transport runs

Table 1 provides design details for the various hybrid variants of the N1, N2 and N3 vehicles broken down by cycles of the three freight transport runs. It shows the respective system performance, broken down by maximum combustion engine and electric motor power, range, to the extent possible emission free (in the vehicle), battery system (capacity and type) and vehicle weight increased in case of necessary additional powertrain components (battery, electric motor, CNG tank), thereby reducing the maximum permissible load. The reference mass is the own mass plus current load.

3. Selected results of the freight transport cycle simulations

The simulation covered each base configuration of the three utility vehicle categories N1, N2 and N3 plus variants of current technology features derived from them as well as hybrid variants right through to a purely Battery Electric Vehicle (BEV).

3.1. Freight transport cycle simulation for diesel-powered vehicles as a function of the level of service

In order to obtain a foundation for interpreting transport logistic tasks, the first step of the simulation concerned only customary diesel-powered utility vehicles operated at LoS A* (e.g. night delivery), C* (e.g. run outside peak traffic) and E* (e.g. scheduled delivery at the morning peak hour). Not surprisingly it was found that the light traffic flow of LoS C* is best suited for goods transport in all three utility vehicle categories and that fuel consumption needs to be measured against this. Diesel consumption increases between 2.6 times (for N1) and 5.6 times (for N3) when the traffic quality deteriorates from C* to E*, as well as by 24% to 30% when the traffic quality improves to A*. This points at the need for innovation in vehicles as well as a traffic management regime that homogenises traffic flows across the day.

3.2. Examples of potentials for reducing energy consumption as a comparison of powertrain variants

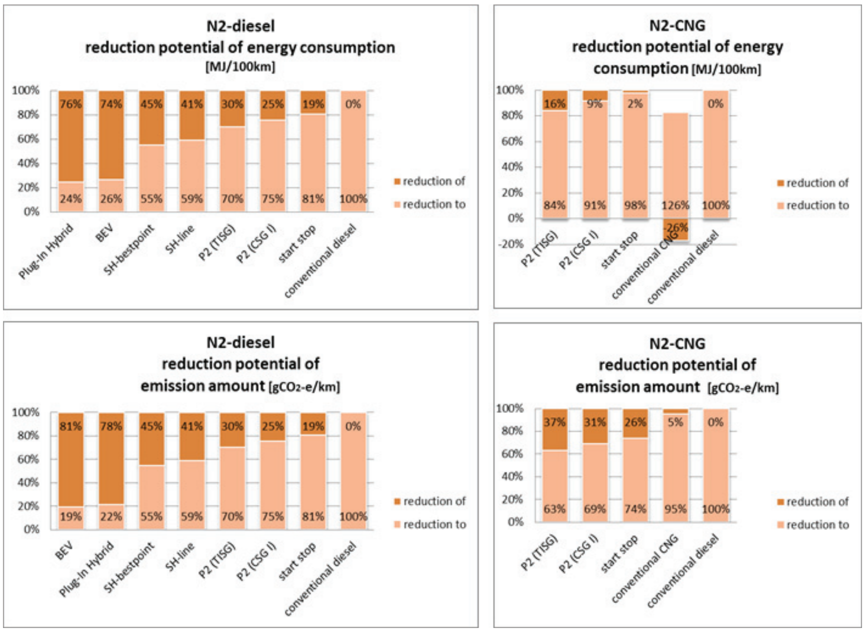

Fig. 1. Reduction potential of energy consumption and CO_2 emissions as simulated for N2 vehicle serving food supply delivery run.

The results for the powertrain variants show up remarkable potentials for reduction, as is exemplarily shown in Fig. 5. For energy consumption the reduction potentials are stated as megajoules per 100 kilometres of driving at model run conditions, ranked by their reduction effects if energy consumption is the primary optimisation target. Similarly, reduction potentials are shown with regard to cutting down on CO_2 emissions, in terms of grammes of CO_2 equivalent per 100 kilometres. It is shown that even minor technological measures, such as the start-stop function (Micro Hybrid), yield substantial savings in energy consumption in the N2 simulation. In terms of energy efficiency and zero emission, purely electrically driven vehicles are hard to beat, but their use is still limited due to the large range required for freight transport. Recuperation is an argument in favour of using purely electric vehicles as well as properly equipped hybrid vehicles that can handle a neuralgic distance without emissions. Of note is the large potential of the Plug-In Hybrid which reduces energy consumption by 76%. Cuts in CO_2 emissions are of a similar scope (78%).

3.3. Sustainability indicators as a tool to evaluate logistic concepts

In addition to performing a comparison of powertrain variants in terms of their reduction potentials within a vehicle category and a typical logistic run, another object was to develop indicators for an overall evaluation. These indicators are based on the gross vehicle weight which changes whenever a delivery is unloaded in the course of a run, and their conversion in tonne-kilometres (tkm) for the transport. Given the different energy types used for driving, the energy consumption was stated in megajoules (MJ) and emissions in grammes of CO_2 equivalents in terms of tonne-kilometres of equivalent gross vehicle weight. The result is a useful table of indicators to evaluate the sustainability of transport runs. The following excerpt shows examples of the best performing powertrain variants for each run and category of utility vehicle (Table 2).

Table 2. Best performing powertrains as simulated by freight transport cycles figured by sustainability indicators.

run parameter for N1-, N2- und N3-vehicles				best performing type of logistic run	simulated energy consumption in megajoules (MJ)		best performing type of logistic run	simulated emission amount CO_2 equivalents in g/tkm vehicle weight (Vw)	
run mile-age	full load equivalent driving performance with departure weight	empty run equivalent driving performance with net weight	transport expenditure to handle the run	best performing powertrain in respect to energy consumption	energy consumption per run (control calculation)	energy consumption in MJ per tkm run specific vehicle weight	best performing powertrain in respect to emission amount	emission amount per run (control calculation)	emission amount in gram per tkm run specific vehicle weight
39,1 km	27,4 km with 3,0 t = 82,20 tkm	11,7 km with 2,5 t = 29,25 tkm	111,45 tkm	**N1-PC-run with Battery Electric Vehicle (BEV)**	68,97 MJ /39,1 km of the run = 1,764 MJ/ km	68,97 MJ per run/ 111,45 tkm per run = **0,619 MJ/ tkm Vw**	**N1-PC-run with Battery Electric Vehicle (BEV)**	3.773,15 gCO_2e/39,1 km of the run = 96,50 gCO_2e/km	3.773,15 gCO_2e per run/111,45 tkm per run = **33,86 gCO_2e/tkm Vw**
40,2 km	20,1 km with 9,35 t = 187,94 tkm	20,1 km with 4,85 t = 97,49 tkm	285,42 tkm	**N2-FSD-run with diesel/Plug-In Hybrid P2/Dual Energy concept**	92,82 MJ/40,2 km of the run = 2,309 MJ/km	92,82 MJ per run/285,42 tkm per run = **0,325 MJ/tkm Vw**	–	–	–
	20,1 km with 9,55 t = 191,96 tkm	20,1 km with 5,05 t = 101,51 tkm	293,46 tkm	–	–	–	**N2-FSD-run with Battery Electric Vehicle (BEV)**	5.523,48 gCO_2e/40,2 km of the run = 137,4 gCO_2e/km	5.523,48 gCO_2e per run/293,46 tkm per run = **18,82 gCO_2e/tkm Vw**
36,0 km	18,0 km with 35,24 t = 634,32 tkm	18,0 km with 15,24 t = 274,32 tkm	908,64 tkm	**N3-IDS-run with diesel/P2 (TISG) Hybrid**	451,33 MJ/36,0 km of the run = 12,537 MJ/km	451,33 MJ of the run/908,64 tkm per run = **0,497 MJ/tkm Vw**	**N3-IDS-run with CNG/P2 (TISG) Hybrid**	28.490,40 gCO_2e /36,0 km of the run = 791,40 gCO_2e/km	28.490,40 gCO_2e per run/908,64 tkm per run = **31,35 gCO_2e/tkm Vw**

PC = Parcel and Courier Services | FSD = Food Supply Deliveries | IDS = Industrial Supplier Service | TISG = Transmission Integrated Starter Generator

Such a table of indicators allows not only comparing the powertrain variants within the same type of logistics run, but it also makes the different logistics runs in respect of their effects measurable. So an evaluation of transport efficiency in respect of sustainability and environmental friendliness is possible. Besides powertrain architecture, special emphasis should be placed on optimisation measures like logistic tour planning in dependency on traffic flow characteristics as well as on the betterment of the net weight to payload ratio due to light weight vehicle design. Fleet operators are looking first and likely only on costs. So, how to implement such an approach in fleet investment and logistic operations strategies?

4. Conclusion and outlook

For this Corporate Social Responsibility of one's own accord could play an impulse-giving role. Or, it would be caused by competitive reasons in the way of external certification. Actually the helping tools for such an extended quality management are not ready enough. On the one hand fleet operation management needs a specific controlling tool and personnel which is capable to serve such a procedure. On the other hand it needs a kind of manual which contains applications for controlling and evaluating the fleet operations of different logistical tasks under different roadway situations. From the very beginning the market´s offer of vehicles equipped with advanced conventional or alternative powertrain systems should be accompanied with convincing argumentations and proofs why a specific powered vehicle is appropriate to the tasks of a fleet operator.

In order to actually achieve the referred reduction potentials, it is, first, necessary to take technological measures affecting the vehicle, including in particular measures concerning powertrain, energy and fuel supply, energy storage and tractive resistance. Secondly, traffic can be more streamlined by efficiently organising the logistic use of the fleet and the enterprise’s locational policy as sources and targets of freight transport lanes. Moreover, (partly) automated and networked transport systems are expected to be developed where the movements of individual vehicles are coordinated with each other and interact with in-time road transport management.

In the future, it will require the methodological integration of approaches to logistic organisation, traffic planning and vehicle engineering in order to achieve a more sustainable design of freight mobility. Such an interdisciplinary approach is suitably known as “intelligent transport logistics”.

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